Mars Pathfinder Microrover - implementing a Low Cost Planetary Mission Experiment

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ABSTRACT

The Mars Pathfinder Microrover Flight Experiment (MFEX) is a NASA OACT flight experiment which is planned to be delivered and integrated with the Mars Pathfinder (MFP) lander and spacecraft system for landing on Mars on July 4, 1997. After landing, the MFEX rover is deployed from the lander and begins a 7 sol (1 sol =1 Martian day) mission to conduct technology experiments, deploy an alpha proton x-ray spectrometer (APXS) on rocks and soil, and image the lander as part of the engineering assessment of the mission after landing.

The MFEX rover is a 6-wheeled vehicle of a rocker bogie design which allows the traverse of obstacles a wheel diameter (13cm) in size. Each wheel has cleats and is independently actuated and geared providing the capability of climbing in soft sand and scrambling over rocks. The rover is powered by a 0.22sqm solar panel providing 16W of peak power. The solar panel is backed up by primary batteries, providing up to 150W-hr of energy. The normal driving power requirement for the microrover is 10W.

Rover components not designed to survive ambient Mars temperatures (-11 0degC during a Martian night) are contained in the warm electronics box (WEB). The WEB is insulated with solid silica aerogel, coated with low emissivity paints, and heated under computer control during the day. This design allows the WEB to maintain components between -40degC and +40degC during a Martian sol.

Vehicle motion control is accomplished through the on/off switching of the drive or steering motors. An average of motor encoder (drive) or potentiometer (steering) readings determines when to switch off the motors. When motors are off, the computer conducts a proximity and hazard detection function, using its laser striping anti camera system to determine the presence of obstacles in its path. The vehicle is steered autonomously to avoid obstacles but cent inues to achieve the commanded goal location.

Command and telemetry is provided by radio modems on the rover and lander. During the day, the rover regularly requests transmission of any commands sent from earth and stored on the lander. When commands arc not available, the rover transmits any telemetry to the lander collected during the last interval between communication sessions.

The total cost of the MFEX mission, including all subsystem design and development, test, integration with the MFP lander and operations on Mars is $25M. At this writing, with approximately two-thirds of the cost incurred, the qualification rover has been built and is being readied for final system integration and test. The components of this rover, implemented in combinat ions of commercial, mil-spec and some space qualified parts, have undergone and passed environment and operational test series derived from that expected in

configuration with the lander and in operation on the Martian surface. These results have allowed the assembly of the flight rover to begin.

This paper discusses the process and the implementation scheme which has resulted in the development of this first Mars rover. The subsystem designs which have proven successful (and not so successful) arc also described in brief along with the requirements and constraints (with cost an integral factor) which resulted in these designs. The qualification status of these subsystems is also presented.